Preoperative Embolization of Brain Tumor with Pial Artery or Dural Branch of Internal Carotid Artery as Feeding Artery

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Summary

This study evaluated the clinical usefulness of preoperative embolization of the pial artery or dural branch of the internal carotid artery (ICA) for brain tumor. Subjects comprised 17 patients with large hypervascular brain tumors who underwent preoperative selective embolization. Micro-catheters (2- or 1.7-F) and shapeable hydrophilic micro-guide wires were used for pial artery (branching from the posterior or anterior cerebral artery) or ICA dural branch embolization.

Embolization was performed under digital subtraction fluoroscopy with Polyvinyl alcohol (PVA) particles (150-250 mm) and/or liquid coil. Tumor resection was performed immediately or the day after embolization. Digital subtraction angiography (DSA) before and after endovascular devascularization, blood loss during tumor resection, and clinical outcome were evaluated. All endovascular procedures were technically successful. Post-embolization DSA revealed either a disappearance or a marked decrease of the tumor stain in all cases. Control of intraoperative bleeding was easily accomplished, and intraoperative blood loss was low. Preoperative particle embolization of the feeding artery from the cortical artery or ICA dural branch is safe and effective as adjuvant therapy before tumor resection.

Introduction

One of the most important issues in the surgical treatment of large hypervascular brain tumors is the securing and coagulation of feeding arteries [1]. However, securing the feeding artery prior to actual tumor resection might be difficult or even impossible in tumors with a feeding artery arising from the deep surface of the operative field [2-7]. For such cases, we performed selective feeder embolization before tumor resection. Large skull-base tumors fed by the dural branch of the internal carotid artery (ICA) or pial arteries (branching from the posterior cerebral artery (PCA) or anterior cerebral artery (ACA)) are indicated for preoperative feeder embolization. Herein we report successful treatment of 17 consecutive patients who underwent preoperative embolization of feeder arteries.

Material and Methods

Subjects comprised 17 consecutive patients with large hypervascular brain tumor fed by ICA dural branches or pial arteries. The feeding artery involved the ICA dural branch in 12 patients (table 1) and the pial artery in five patients (PCA, n=3; ACA, n=2; table 2). All patients were treated using the same protocol. All ICA dural branch embolizations were per-

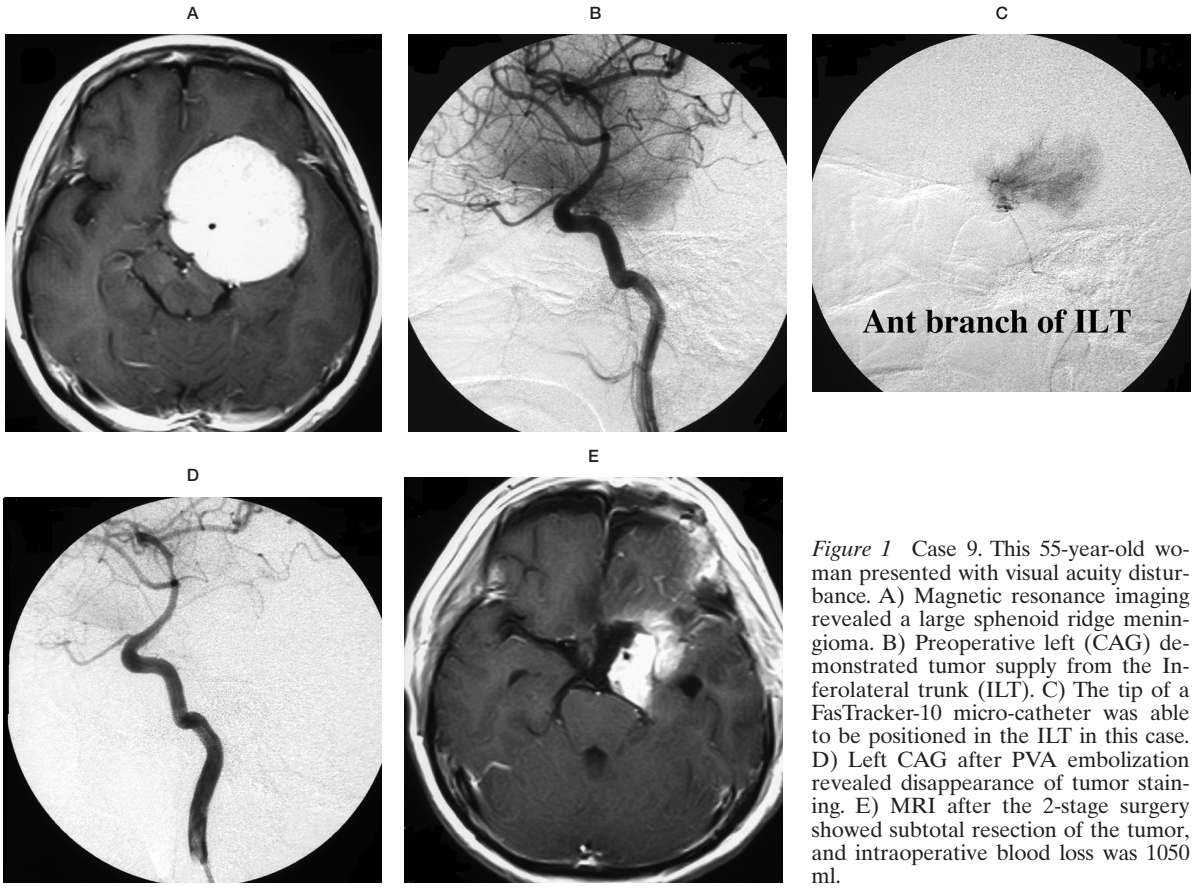

Figure 1 Case 9. This 55-year-old woman presented with visual acuity disturbance. A) Magnetic resonance imaging revealed a large sphenoid ridge meningioma. B) Preoperative left (CAG) demonstrated tumor supply from the Inferolateral trunk (ILT). C) The tip of a FasTracker-10 micro-catheter was able to be positioned in the ILT in this case. D) Left CAG after PVA embolization revealed disappearance of tumor staining. E) MRI after the 2-stage surgery showed subtotal resection of the tumor, and intraoperative blood loss was 1050 ml.

formed under local anesthesia one day before tumor resection. We have already published details of these embolizations [4]. All pial artery embolizations were performed under general anesthesia just before tumor resection. A biplane digital subtraction angiography (DSA) system (Advantx LCN Plus; GE) was used for all patients. Medical records and images were reviewed retrospectively.

Endovascular treatment

ICA Dural Branch Embolization

Details of this procedure have already been published [4]. In all patients, embolization was performed using the routine transfemoral technique, comprising the Seldinger technique with local anesthesia and systemic heparinization. A steam-shaped (J-form) non-braided 2-F microcatheter (FasTracker-10; Boston Scientific, Fremont, CA) was navigated into the feeding artery using digital road mapping. PVA (Polyvinyl alcohol) suspension (125-150 mm) was then carefully hand-injected through the micro-catheter. Injection of embolic materials was continuously monitored under high-quality digital subtraction fluoroscopy (DSF).

Pial Artery Embolization

Pial artery embolization was also performed using routine Seldinger technique under general anesthesia. A 1.7-F micro-catheter (Excelsior sL-10; Boston Scientific) was navigated into the feeding artery just proximal to the tumor using digital road mapping. A liquid coil 10 (Boston Scientific) and PVA (125-250 mm) were used for embolization. Patients were transferred to the operating theater immediately after embolization.

Results

ICA Dural Branch Embolization (figure 1, 2)

Pretreatment symptoms, size and location of tumors, and feeding arteries from the ICA are shown in table 1. In all 12 patients, insertion of the micro-catheter into the dural branch of the ICA was performed successfully. Almost com-

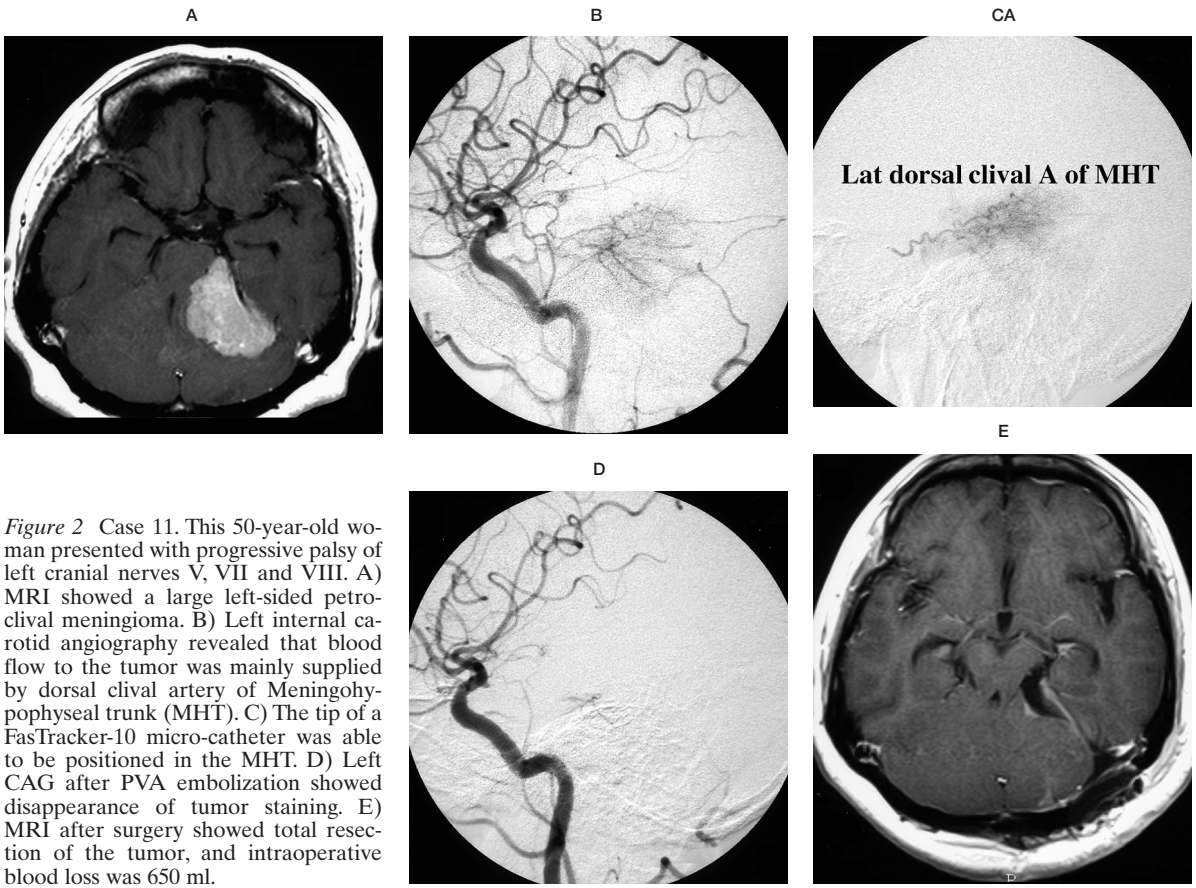

Figure 2 Case 11. This 50-year-old woman presented with progressive palsy of left cranial nerves V, VII and VIII. A) MRI showed a large left-sided petroclival meningioma. B) Left internal carotid angiography revealed that blood flow to the tumor was mainly supplied by dorsal clival artery of Meningohypophyseal trunk (MHT). C) The tip of a FasTracker-10 micro-catheter was able to be positioned in the MHT. D) Left CAG after PVA embolization showed disappearance of tumor staining. E) MRI after surgery showed total resection of the tumor, and intraoperative blood loss was 650 ml.

Table 1 **Summary of clinical and radiological data (Tumor with feeding artery from ICA dural branch).**

Case No	Age/ Sex	Size of tumor (mm)	Location of tumor	Feeding artery	Tumor stein after TAE	Extend of tumor	Blood loss (ml)	Outcome (mRS)
1	54/F	60x60x30	Petroclival	Post branch of ILT	M decreased	Subtotal (2stage)	740	2
2	50/F	50x46x30	Petroclival	Post branch of ILT	M decreased	Subtotal	340	1
3	56/F	24x34x30	Petroclival	Lat dorsal clival A of MHT	Disappeared	Partial	320	0
4	49/F	50x42x42	Petroclival	Lat dorsal clival A of MHT	M decreased	Total	385	0
5	72/F	60x50x50	Sphenoid ridge	Sup branch of ILT	Disappeared	Subtotal	590	2
6	42/F	60x30x50	Petroclival	Marginal Tent A of MHT	M decreased	Partial	230	0
7	45/F	20x30x20	Petroclival	Lat dorsal clival A of MHT	M decreased	Total	260	0
8	67.F	33x19x22	Petroclival	Lat dorsal clival A of MHT	Disappeared	Total	760	0
9	55/F	72x62x65	Sphenoid ridge	Ant branch of ILT	Disappeared	Subtotal (2 atage)	1050	1
10	49/F	32x30x35	Petroclival	Lat dorsal clival A of MHT	Disappeared	Partial	290	2
11	50/F	45x40x45	Petroclival	Lat dorsal clival A of MHT	M decreased	Total	650	0
12	38/F	55x50x53	Petroclival	Marginal Tent A of MHT	Disappeared	Total	790	0

Post: Posterior - ILT: Inferolateral trunk - Lat: Lateral - MHT: Meningohypophyseal trunk - Sup: Superior - Tent T: Tentorial aetery
M decreased: Markedly decreased - mRS: modified Rankin Scale

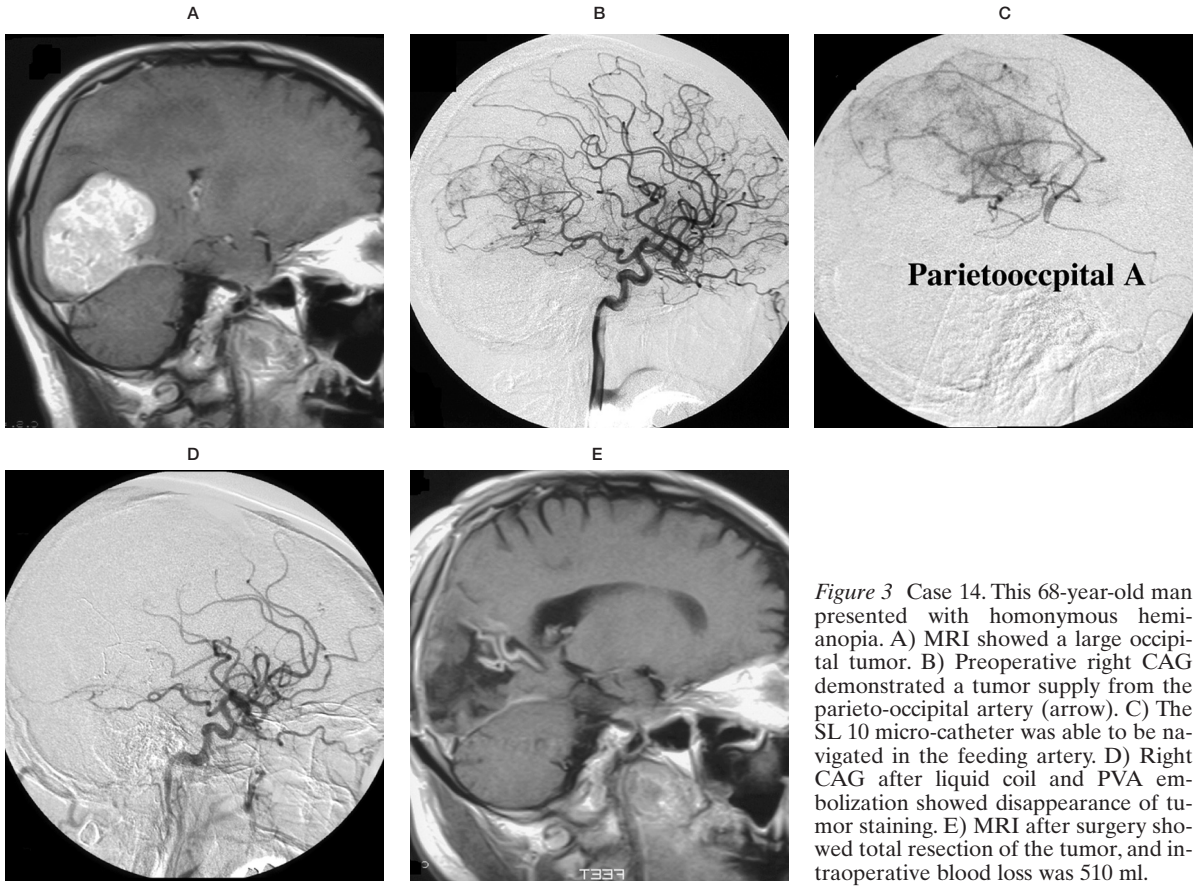

Figure 3 Case 14. This 68-year-old man presented with homonymous hemianopia. A) MRI showed a large occipital tumor. B) Preoperative right CAG demonstrated a tumor supply from the parieto-occipital artery (arrow). C) The SL 10 micro-catheter was able to be navigated in the feeding artery. D) Right CAG after liquid coil and PVA embolization showed disappearance of tumor staining. E) MRI after surgery showed total resection of the tumor, and intraoperative blood loss was 510 ml.

plete embolization with contrast stasis was obtained in six patients, and a marked decrease in tumor staining from the pre-embolization baseline was demonstrated in six patients. No complications related to endovascular procedures were encountered. Intraoperative control of bleeding during tumor resection was easily managed, with a mean intraoperative blood loss of 526 ml (range, 230-790 ml). Total or subtotal resection was achieved in ten of the 12 cases. In the remaining two cases, only partial resection was possible due to cranial nerve adhesion to the target tumor. Histological diagnosis comprised meningioma (n = 10) or hemangiopericytoma (n = 2). Outcomes at discharge were favorable in all patients.

Pial Artery Embolization (figure 3, 4)

Pretreatment symptoms, size and location of tumors, and feeding arteries are shown in table 2. In all patients, insertion of the micro-catheter into the distal ACA or PCA branch was performed successfully. A marked decrease in tumor staining was demonstrated in all patients. Mean intraoperative blood loss was 496 ml (range, 250-1060 ml). Total resection was achieved in all patients. Histological diagnosis comprised meningioma (n = 2), metastatic brain tumor (n = 2) or sarcoma (n = 1). Outcomes at discharge were favorable in all patients.

Discussion

The use of preoperative embolization for large skull-base meningiomas has been advocated to devascularize these tumors, permitting decreased intraoperative morbidity and improved cure through hemostasis, and also providing a relatively clear and better-visualized surgical field [1,4,5,7]. Typically, skull-base meningiomas are fed not only by branches of the external carotid artery, but also by dural branches of the ICA [4,5,7]. However, ICA-supplied branches are often very small, and are consequently often inaccessible to direct micro-catheter cannulation. In addition, branches arising from the petrous ICA often arise at an acute angle. These anatomical relationships create chal-

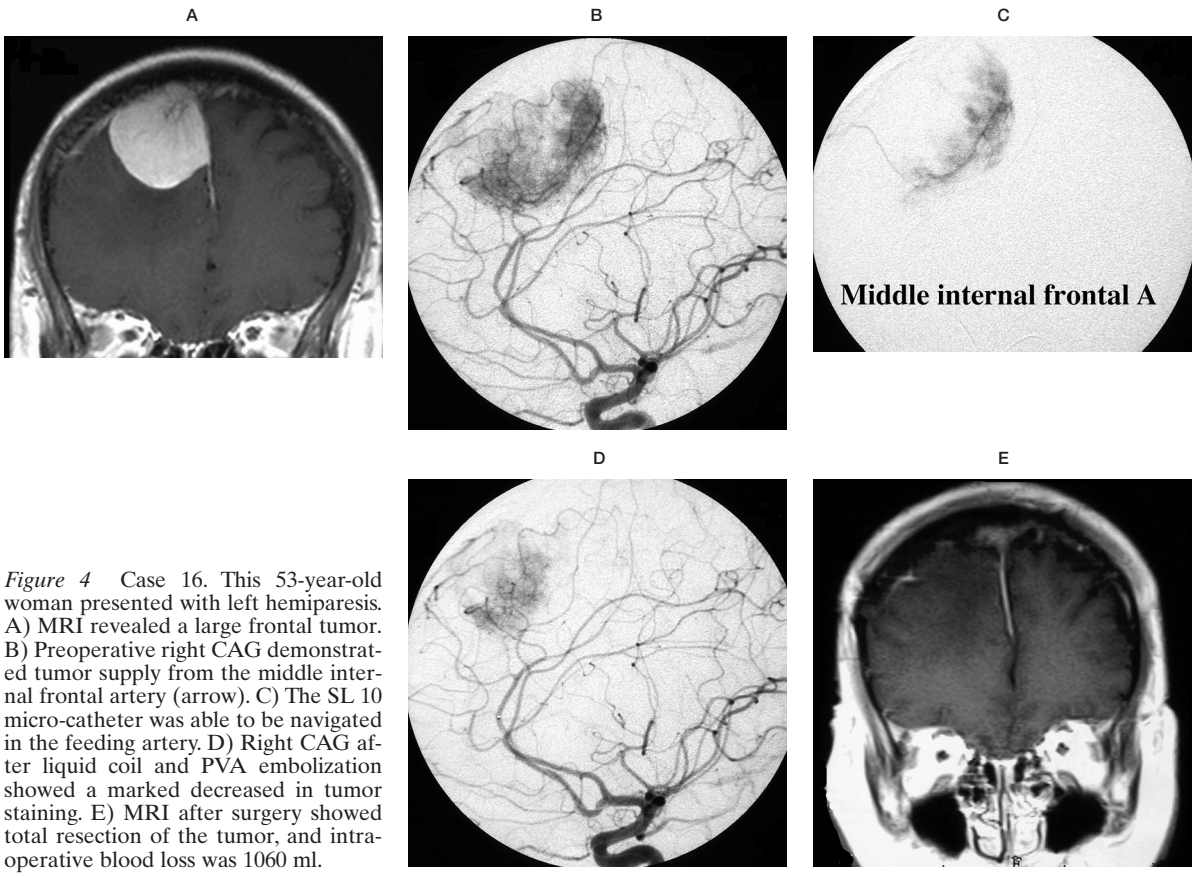

Figure 4 Case 16. This 53-year-old woman presented with left hemiparesis. A) MRI revealed a large frontal tumor. B) Preoperative right CAG demonstrated tumor supply from the middle internal frontal artery (arrow). C) The SL 10 micro-catheter was able to be navigated in the feeding artery. D) Right CAG after liquid coil and PVA embolization showed a marked decreased in tumor staining. E) MRI after surgery showed total resection of the tumor, and intraoperative blood loss was 1060 ml.

lenges to direct catheterization [2-4,6,7]. However, the simultaneous development of high-resolution road mapping with the concurrent development of softer and smaller micro-catheters and micro-guide wires have recently enabled selective embolization, even in cases involving petrous ICA branches [2-4,6,7].

In the present series, we were able to successfully navigate micro-catheters into small feeding vessels and safe embolization was achieved. However, even when a catheter is successfully introduced into the supplying vessel that proceeds on to the embolization target, further advancement of the catheter into a dis-

Table 2 **Summary of clinical and radiological data (Tumor with feeding artery from pial artery).**

Case No	Age/ Sex	Size of tumor (mm)	Location	Feeding artery	Tumor stein after TAE	Extend of tumor	Blood loss (ml)	Outcome (mRS)
13	68/M	52x53x65	Occipital	PCA (Parietooccpital A)	M decreased	Total	510	0
14	63/M	55x43x50	Occipital	PCA (Calcarine A)	M decreased	Total	505	2
15	41/F	53x50x51	Parieto Occipital	PCA (Calcarine A)	M decreased	Total	250	1
16	29/M	62x53x50	Frontal	ACA (middle internal frontal A)	M decreased	Total	1060	0
17	53/F	23x45x40	Frontal	ACA (middle internal frontal A)	M decreased	Total	650	0

A: artery - M decreased: Maekedly decreased - mRS; Modified Rankin Scale

tal position may remain particularly challenging due to catheter-to-vessel size issues. This procedure often leads to unfavorable vasospasm, or to inadvertent perforation of these small and fragile feeding vessels, which frequently possess hairpin turns [8].

Due to significant concerns about inadvertent reflux of embolic material into the parent ICA from inadvertent overflow during embolic hand injection, we utilized representative non-embolic test injections with contrast medium, and performed continuous and prolonged angiographic monitoring (using DSF) to avoid such unexpected reflux of embolic materials [2-4,6].

Additional considerations specific to this surgical location include the vascular supply to the cranial nerves, since the described dural branches from the carotid artery may also supply the adjoining cranial nerves. Due to the risk of inadvertent embolization of cranial nerves in the skull base, some researchers have advocated using pre-embolization selective lidocaine to assess the possible risk of post-embolization ischemic cranial neuropathies [6]. A theoretical risk of intracranial reflux remains when lidocaine is used to test skull-base branches, and lidocaine reflux into the ICA may result in seizures. In addition, false-negative and false-positive provocative tests have been reported [3,6]. Since the vasa nervorum is small, utilization of particles larger than 150 mm has been suggested as a strategy to protect against the risk of ischemic cranial nerve injury [1,6]. We therefore performed embolization with 125-250 mm PVA without provocative testing in our patients, an approach that seems feasible given the lack of complications.

Few reports have described preoperative embolization of brain tumors with a pial blood supply [5]. However, resection of large hypervascular brain tumors fed by branches of the ACA or PCA is very difficult. To expose and secure the feeding artery is very difficult, as the feeding artery arises from the deep surface of the operative field. In such cases, we performed preoperative embolization. Large hypervascular brain tumors with a pial supply usually display massive peritumoral brain edema. To diminish the risk of post-embolization brain edema secondary to post-embolization tumor swelling, all embolization was performed under general anesthesia immediately before tumor resection.

Conclusions

In this study, we report successful cases of selective pial artery or ICA dural branch embolization performed with the combined use of a micro-catheter and micro-guide wire. Using this method, we demonstrated both clinical utility and angiographically successful embolization for all patients in this series. Preoperative particle embolization of the feeding artery from a cortical artery or ICA dural branch appears to represent a safe and effective adjuvant therapy before tumor resection.

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